

FRAMING NAILS

HOLDING POWER OF NAILS

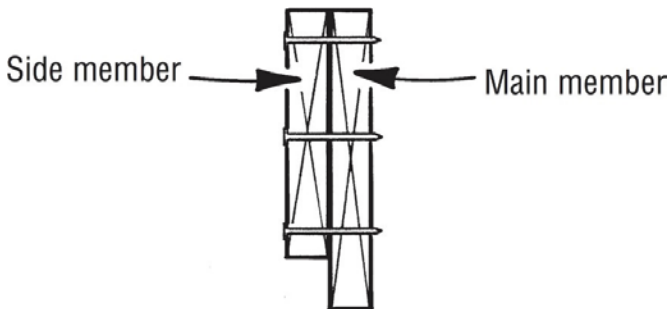
A nail's holding power is a function of its diameter, how far it penetrates the wood, and the type of wood it penetrates. In framing, nails should never be loaded in withdrawal (where the load acts parallel to the nail shank and tries to pull it out). Instead, framing nails should be loaded only laterally (where the load acts perpendicular to the shank). Also, nails have more holding power when driven into the side grain rather than into the end grain. In fact, nailing into the end grain will reduce a nail's lateral load capacity by approximately one-third.

Holding Power
of Nails

Box vs. Common Nails

Lateral strength is largely a function of a nail's diameter and the density of the type of wood into which the nail is driven. For example, 10d and 12d nails have the same diameter and the same lateral strength in each type of wood. Common nails are stronger than box nails because of their greater diameter (Figure A).

FIGURE A: LATERAL STRENGTH OF COMMON VS. BOX NAILS



Penny Wt.	8d		10d		12d		16d		20d	
Nail Type	Common	Box	Common	Box	Common	Box	Common	Box	Common	Box
Diameter (in.)	0.131	0.113	0.148	0.128	0.148	0.128	0.162	0.135	0.192	0.148
Side Member Thickness (in.)	0-3/4		0-3/4		0-3/4		1 1/2		1 1/2	
Lateral Rating (lb.)										
SPF	70	57	83	68	83	68	120	88	144	100
D-F-L	90	72	105	87	105	87	141	103	170	118
Hem-Fir	73	58	85	70	85	70	122	89	147	102
SYP	104	79	121	101	121	101	154	113	185	128

Nails are rated for "lateral capacity," which is greatly affected by the nail's diameter. Since box nails are skinnier than commons, they have lower strength values. The values shown vary with the type of framing lumber used, and they assume the nail will penetrate the main member (illustration at top) at least 12 diameters.

When substituting box for common nails, calculate the nail size needed using the conversion ratios in **Figure B**.

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FIGURE B: CONVERSION RATIO FOR COMMON TO BOX NAILS

Penny Wt.	8d	10d	12d	16d	20d
Ratio	1.23	1.22	1.22	1.36	1.44

S-P-F lumber assumed.

Do not substitute a common nail that's specified on the plans for an equal number of box nails. Instead, multiply the specified number of common nails by the conversion ratio shown in the chart and round up to find the equivalent number of box nails.

Withdrawal Strength of Nails

Nails are much stronger when loaded laterally (across the nail) than when loaded in withdrawal (along the length of the nail). Withdrawal from end grain is particularly weak and not accepted as a structural connection by most codes. Withdrawal values from sidegrain are given in **Figure C**.

FIGURE C: WITHDRAWAL STRENGTH DESIGN VALUES IN POUNDS OF COMMON VS. BOX NAILS

Penny Wt.	8d		10d		12d		16d		20d	
Nail Type	Common	Box	Common	Box	Common	Box	Common	Box	Common	Box
Diameter (in.)	0.131	0.113	0.148	0.128	0.148	0.128	0.162	0.135	0.192	0.148
Withdrawal Value										
SPF	21	18	23	20	23	20	26	21	30	23
D-F-L	32	28	36	31	36	31	40	33	47	36
Hem-Fir	22	19	25	21	25	21	27	23	32	25
SYP	41	35	46	40	46	40	50	42	59	46

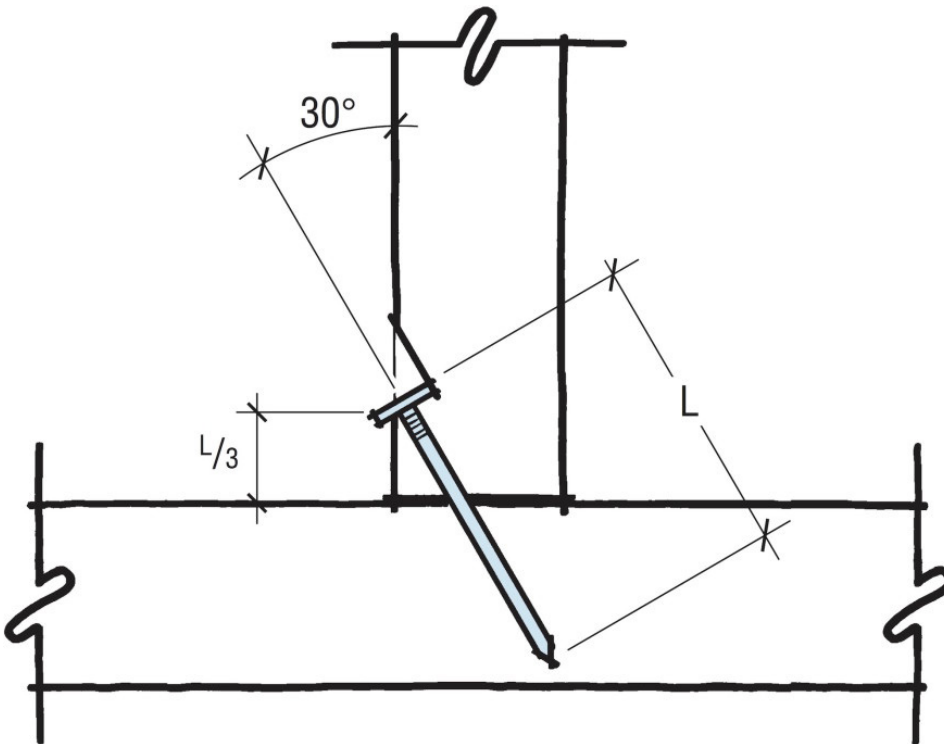
This table shows the allowable load values for typical common and box nails. These values are in pounds per inch of penetration into the side grain of the main member.

Toenails

For toenails loaded in withdrawal, multiply the values in **Figure C**, above, by .67. For toenails loaded laterally, multiply the values in **Figure A**, by .83. Toenails should be driven at an angle of about 30 degrees from the face of the stud or other member being attached (**Figure D**).

Holding Power
of Nails

FIGURE D: PROPER TOENAILING



Place toenails away from the end of the board a distance that's equal to one-third the length of the nail. Angle the nail so it comes through at the center of the board's thickness.

PNEUMATIC NAILS

Pneumatic nails are typically sold by a specified shank diameter in inches (.120, .131, and .148 are common for framing nails). These are typically skinnier than common nails of equal length and, therefore, have lower lateral strength and withdrawal values (**Figure E**). Consult manufacturers for lateral strength of specific nail types.

Pneumatic Nails

FIGURE E: LATERAL STRENGTH OF AIR NAILS

Nail Length	Nail Diameter	Wood Species			
		SPF	DFL	Hem-Fir	SYP
2 1/2"	0.131"	52	62	54	67
3"	0.12"	69	81	71	89
3"	0.131"	79	93	80	101
3"	0.148"	84	99	86	109
3 1/4"	0.12"	69	81	71	89
3 1/4"	0.131"	79	93	80	101
3 1/2"	0.162"	92	109	94	119

Values are based on a 10-year "normal" load duration, and assume: 1) smooth-shank nails driven perpendicular to the wood grain; and 2) both side and main members are of the same wood species. When toenailing, multiply the values by .83, as described in "Toenails," above.

FIGURE F: WITHDRAWAL STRENGTH OF AIR NAILS

Nail Diameter	Wood Species			
	SPF	DFL	Hem-Fir	SYP
0.12"	19	29	20	37
0.131"	21	32	22	41
0.148"	23	36	25	46
0.162"	26	40	27	50

Withdrawal values (pounds per inch of penetration into the main member) are based on a 10-year "normal" load duration, and assume: 1) smooth-shank nails driven perpendicular to the wood grain; and 2) both side and main members are of the same wood species. When toenailing, multiply the values by .83, as described in "Toenails," above.

STAINLESS STEEL NAILS

While expensive, stainless-steel nails are the most rust-resistant under nearly all conditions. They are highly recommended below grade or in homes that will be exposed to salt air. They're also recommended for cedar or redwood trim, and for siding that will be left to weather without stain or paint. Stainless-steel nails are typically available as Type 304 and 316. The 316 type are more durable.

Stainless Steel Nails

Aluminum Nails

ALUMINUM NAILS

Aluminum nails are sometimes used to fasten exterior siding. They're very resistant to rust and corrosion, but may corrode when used with some flashing metals.

Nailing Rules of Thumbs

NAILING RULES OF THUMB

Typical nailing schedules appear in **Figure G**.

Two is better than one. In general, never rely on a single nail. Use at least two.

Nail spacing. Don't space nails closer than one-quarter their length to the edge of the board.

Nail penetration. To hold at full strength, nails should penetrate the wood a depth that's at least 11 times their diameter — 1 1/2 in. for 8d nails and 1 3/4 in. for 16d nails.

FIGURE G: NAILING SCHEDULES

Roof Framing	Number of Common Nails	Number of Air Nails
Rafter to top plate (toe nailed) *	3-8d per rafter	3-3 x .131 per rafter
Ceiling joist to top plate (toe-nailed) *	3-16d per joist	5-3 x .131 per rafter
Ceiling joist parallel rafter (face-nailed) *	3-16d per joist	4-3 x .131 * per rafter
Ceiling joist laps over partitions (face-nailed)	3-16d per lap	4-3 x .131 per rafter
Collar tie to rafter (face nailed) *	3-16d per joist *	4-3 x .131 per rafter
Blocking to rafter (toe-nailed)	2-8d each end	2-3 x .131 each end
Roof rafter to ridge beam *	3-10d per rafter	3-3 x .131 per rafter
Jack rafter to hip (toe-nailed)	3-10d per rafter	3-3 x .131 per rafter
Roof Sheathing *		
Structural panels	1-8d every 6 in. edge, 12 in. field	1-2 1/2 x .131 every 6 in. edge, 12 in. field

Continued on next page

FIGURE G: NAILING SCHEDULES (CONTINUED)

Nailing Rules of
Thumbs

Wall Framing		
Top or bottom plate to stud (end-nailed) *	2-16d per stud	3-3 x .131 per stud
	3-16d per 2X6 stud	4-3 x .131 per stud
Top of bottom plate to stud (toe-nailed) *	3-16d per stud	4-3 x .131 per stud
	4-16d per 2X6 stud	
	5-16d per stud	3-3 x .131 per stud
Top plate to top plate (face-nailed) *	2-16d every 16 in.	2-3 x .131 every 12 in.
Top plates at intersections (face-nailed)	2-16d each side of joint	4-3 x .131 each side of joint
Stud to stud (face-nailed)	2-16d every 24 in.	2-3 x .131 every 16 in.
Header to header (face-nailed)	1-16d every 16 in. along edges	1-3 x .131 every 12 in. along edges
Bottom plate to floor joist, band joist, end joist, or blocking (face-nailed)	1-16d every 16 in.	1-3 x .131 every 8 in. along edges
Wall Sheathing *		
Structural panels	1-8 every 6 in. edge, 12 in. field	1-2 1/2 x .131 every 6 in. edge, 12 in. field
Floor Framing		
Joist to sill, top plate or girder (toe-nailed)	4-8d per joist	4-3 x .131 per joist
Bridging to joist (toe-nailed)	2-8d each end	2-2 1/2 x .131 each end
Blocking to joist (toe-nailed)	2-8d each end	2-2 1/2 x .131 each end
Blocking to sill or top plate (toe-nailed)	3-16d each block	4-3 x .131 each block
Ledger strip to beam (face-nailed)	3-16d below each joist	4-3 x .131 below each joist
Joist on ledger to beam (toe-nailed)	3-8 per joist	3-3 x .131 per joist
Rim joist to joist (end-nailed)	3-16d per joist	4-3 x .131 per joist
Rim joist to sill or top plate (toe-nailed) *	2-16d every 12 in.	2-3 x .131 every 8 in.
Floor Sheathing		
Structural Panels - 1 in. or less	1-8d every 6 in. edge, 12 in. field	1-2 1/2 x .131 every 6 in. edge, 12 in. field
Structural Panels - Greater than 1 in.	1-10d every 6 in. edge, 6 in. field	1-3 1/4 x .131 every 6 in. edge, 6 in. field

* For high wind areas, consult local codes.